Corn Nitrogen Rate Calculator

Impact of Nitrogen Application Timing on Corn Production

John E. Sawyer
Daniel W. Barker
John P. Lundvall
Department of Agronomy
Iowa State University
CORN NITROGEN RATE CALCULATOR
Finding the Maximum Return To N and Most Profitable N Rate
A Regional (Corn Belt) Approach to Nitrogen Rate Guidance

This website provides a process to calculate economic return to N application with different nitrogen and corn prices and to find profitable N rates directly from recent N rate research data. The method used follows a regional approach for determining corn N rate guidelines that is implemented in several Corn Belt states.

START HERE
Choose how you want to calculate N rates, using one set of prices or using multiple prices.

SINGLE PRICE  MULTIPLE PRICE

In association with these Universities

For questions about the Corn Nitrogen Rate Calculator website contact John Sawyer at sawyer@iastate.edu

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http://cnrc.agron.iastate.edu/
## Corn Nitrogen Rate Calculator
### Main Iowa Area

### Rates and Charts

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>State: Iowa</td>
<td></td>
</tr>
<tr>
<td>Region: Main</td>
<td></td>
</tr>
<tr>
<td>Number of sites: 204</td>
<td></td>
</tr>
<tr>
<td>Rotation: Corn Following Soybean</td>
<td></td>
</tr>
<tr>
<td>Nitrogen Price ($/lb)</td>
<td>0.35</td>
</tr>
<tr>
<td>Corn Price ($/bu)</td>
<td>3.50</td>
</tr>
<tr>
<td>Price Ratio</td>
<td>0.10</td>
</tr>
<tr>
<td>MRTN Rate (lb N/acre)</td>
<td>134</td>
</tr>
<tr>
<td>Profitable N Rate Range (lb N/acre)</td>
<td>121 - 148</td>
</tr>
<tr>
<td>Net Return to N at MRTN Rate ($/acre)</td>
<td>$174.47</td>
</tr>
<tr>
<td>Percent of Maximum Yield at MRTN Rate</td>
<td>99%</td>
</tr>
<tr>
<td>Anhydrous Ammonia (82% N) at MRTN Rate (lb product/acre)</td>
<td>163</td>
</tr>
<tr>
<td>Anhydrous Ammonia (82% N) Cost at MRTN Rate ($/acre)</td>
<td>$46.90</td>
</tr>
</tbody>
</table>
Comparison of Low and Upper End of Profitable N Rate Range
Ames (Clarion Loam) SC (2000-2015)

Using Low End of Profitable Range
121 lb N/acre MRTN Rate (0.10 price ratio)

Using Upper End of Profitable Range
148 lb N/acre MRTN Rate (0.10 price ratio)

J.E. Sawyer, ISU
Comparison of Low and Upper End of Profitable N Rate Range
Ames (Clarion Loam) SC (2000-2015)

Using Low End of Profitable Range
121 lb N/acre (0.10 price ratio)
$0.35/lb N and $3.50/bu
Potential Increase if Yearly EONR: $13.33/acre

Using Upper End of Profitable Range
148 lb N/acre (0.10 price ratio)
$0.35/lb N and $3.50/bu
Potential Increase if Yearly EONR: $10.56/acre

Using Low End of Profitable Range
121 lb N/acre (0.10 price ratio)
$0.35/lb N and $3.50/bu
Potential Increase if Yearly EONR: $13.33/acre

Using Upper End of Profitable Range
148 lb N/acre (0.10 price ratio)
$0.35/lb N and $3.50/bu
Potential Increase if Yearly EONR: $10.56/acre
Extremes in Nitrogen Response are Important
Ames (Clarion Loam) SC (2000-2015)

Years within ±25 lb N/acre range (109-159 lb N/acre) of the MRTN at 134 lb N/acre (0.10 price ratio)
$0.35/lb N and $3.50/bu
Potential Increase if Used Yearly EONR Instead of MRTN: $2.44/acre

10 of 16 years within 109-159 lb N/acre range.

J.E. Sawyer, ISU
Spring Precipitation as a Tool for Decisions About Additional Nitrogen Application (Main Iowa)

J.E. Sawyer, ISU

Overall Correct: 76%

Ames-Lewis-Kanawha-Nashua-Sutherland (SC and CC)

Correct: 58%
Incorrect: 14%
Total at 15.5 Inches

Incorrect: 10%
Correct: 18%

April through June Precipitation Total (Inch)
The APSIM Model
Agricultural Production Systems sIMulator

A model is a computer program that integrates scientific knowledge in the form of mathematical equations and attempts to represent a real world system.

APSIM is a modular process-based model for simulating agricultural systems.

ISU development/evaluation for optimal N-rate prediction in corn.
APSIM Modelling Corn Yield Across N Rates
Initial Evaluation of Model Performance
(Ames Site CC)

Full N

Zero N

Puntel et al., 2016
Frontier Plant Science
APSIM Modelling Optimal N Rate Initial Evaluation (Ames Site SC and CC)

When Yearly EONR Is Within One of these Three N Rate Categories How Well Does APSIM Hit the Yearly EONR Extremes?
Impact of Nitrogen Application Timing on Corn Production

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Nitrogen Application Timing Studies

- Nine studies in 2004-2016
- Seventy one site-years
- Nitrogen application timings
  - Fall, spring preplant, at planting, split/sidedress, mid-vegetative, late-vegetative
- Question?
  - Nutrient reduction strategy and 4R management
  - 4% yield increase fall to spring preplant
  - 0% yield increase spring preplant to sidedress
2004-2015 High Precipitation Period

Accumulated Precipitation (in): Departure from Mean
January 1, 2004 to December 31, 2015

Mean period is 1981–2010.
Anhydrous Ammonia Timing Study

- Late fall (< 50°F), spring preplant (mid-April to mid-May) & split/sidedress (V2-V4 corn stage, early-mid June)
- Five N rates
- No nitrification inhibitor
- Corn following soybean
- Three years (2007-2009)
- Ames
Preplant and Split/Sidedress
Anhydrous Ammonia

Anhydrous Ammonia, 2007-2009

Yield (bu/acre)

Nitrogen Rate (lb N/acre)

- Fall
- EONR
- Preplant
- Sidedress
- EONR

Sawyer, Barker, Hanna, 2009

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J.E. Sawyer, ISU
Springtime Timing Studies

- Spring preplant or at-planting & split/sidedress
- Sidedress at V4 – V9 corn growth stage
- Six to eight N rates
- UAN, urea, ammonium nitrate
- Corn following soybean
- Three years (2014-2016)
- Fourteen site-years across Iowa
Preplant or At-Planting and Split/Sidedress

Nitrogen Application Timing Sites (2014-2016)

Sawyer, Lundvall, Hall, Barker 2014-2016.

Solid line is preplant/plant.
Dashed line is split/sidedress.
## Preplant or At-Planting and Split/Sidedress

<table>
<thead>
<tr>
<th>Category</th>
<th>Sites</th>
<th>Pre</th>
<th>Split</th>
<th>Pre</th>
<th>Split</th>
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<tbody>
<tr>
<td>Split EONR at least 10 lb N/acre lower than Preplant</td>
<td>4</td>
<td>167</td>
<td>138</td>
<td>202</td>
<td>201</td>
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<tr>
<td>Preplant EONR at least 10 lb N/acre lower than Split</td>
<td>3</td>
<td>108</td>
<td>126</td>
<td>203</td>
<td>206</td>
</tr>
<tr>
<td>Preplant and Split EONR within 10 lb N/acre</td>
<td>7</td>
<td>151</td>
<td>147</td>
<td>221</td>
<td>221</td>
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<tr>
<td>Overall Mean</td>
<td>14</td>
<td>146</td>
<td>140</td>
<td>212</td>
<td>212</td>
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<tr>
<td>Chariton (2015)</td>
<td>1</td>
<td>250*</td>
<td>250*</td>
<td>134</td>
<td>129</td>
</tr>
</tbody>
</table>

*Based on N response equations and 0.10 N:corn price ratio. Sawyer, Lundvall, Hall, and Barker, 2014-2016.*
In-Season Sensor-Based Project

- Spring preplant or early sidedress (Pre-N)
- In-season mid- to late-vegetative SPAD meter-based high clearance (Post-sensing N)
- Four Pre-N rates plus sensor-based N
- UAN Post-sensing N product
- Corn following soybean
- Three years (2004-2006)
- Thirty on-farm sites across Iowa with field-length strips
### N Applied Pre and Post-Sensing

<table>
<thead>
<tr>
<th>N Application Treatment</th>
<th>Mean with Post-Sensing</th>
<th>Relative CM Value</th>
<th>Mean Yield ‡</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Total N Applied †</td>
<td>N Applied</td>
<td></td>
</tr>
<tr>
<td></td>
<td>lb N/acre</td>
<td>n</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>--</td>
<td>0.82</td>
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<td>60</td>
<td>60</td>
<td>--</td>
<td>0.93</td>
</tr>
<tr>
<td>60+</td>
<td>115</td>
<td>28</td>
<td>---</td>
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<tr>
<td>120</td>
<td>120</td>
<td>--</td>
<td>0.97</td>
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<tr>
<td>120+</td>
<td>131</td>
<td>9</td>
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<tr>
<td>240</td>
<td>240</td>
<td>--</td>
<td>1.00</td>
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</table>

† Sum of Pre-N and Post-sensing N rate, averaged across all 30 SC sites.
‡ Mean yields are not significantly different when followed by the same letter ($P \leq 0.10$).

Hawkins, Lundvall, Sawyer, 2006
Mid-Vegetative Sensor-Based Timing Study

- Spring preplant urea (PP-N)
- Mid-vegetative (V10 stage) active canopy sensor-based application (PP+S-N)
- Seven PP-N rates plus sensor-based N
- UAN Post-sensing N product
- Corn following soybean
- Two years (2009-2010)
- Central Iowa, new site each year
N Applied Preplant and Mid-Vegetative Based on Canopy Sensing

Barker and Sawyer, 2012
Mid-Vegetative Sensor-Based Demonstration

- **Preplant N Rate (PP-N)**
  - Farmer rate and product (Fall, Sp, Split, NH₃, NS, UAN)

- **Preplant + In-Season Fixed Rate (PP+F-N)**
  - Farmer rate + 100 lb urea/acre (46 lb N)

- **Preplant + In-Season Sensor Rate (PP+S-N)**
  - Farmer rate + 3 potential sensor-based rates
  - Un-calibrated NDVI (no relative index)
    - 1) ≥0.85 no N; 2) 0.85-0.50 100 lb urea/acre (46 lb N); 3) <0.50 150 lb urea/acre (70 lb N)
  - Sensor-based N applied June 28–30, 2011

- **Multiple fields**
## Sensor-Based Demonstration SC

<table>
<thead>
<tr>
<th>Application</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<tbody>
<tr>
<td>PP-N</td>
<td>218</td>
<td>213</td>
<td>211</td>
<td>212</td>
<td>212</td>
<td>198</td>
</tr>
<tr>
<td>PP+F-N</td>
<td>217</td>
<td>214</td>
<td>199</td>
<td>194</td>
<td>223</td>
<td>193</td>
</tr>
<tr>
<td>PP+S-N</td>
<td>219</td>
<td>206</td>
<td>209</td>
<td>222</td>
<td>205</td>
<td>198</td>
</tr>
<tr>
<td>Sign. (0.05)</td>
<td>NS</td>
<td>NS</td>
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<td>NS</td>
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<td>NS</td>
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</table>

<table>
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<tr>
<th>Application</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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</thead>
<tbody>
<tr>
<td>PP-N</td>
<td>159</td>
<td>161</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>160</td>
</tr>
<tr>
<td>PP+F-N</td>
<td>205</td>
<td>206</td>
<td>205</td>
<td>205</td>
<td>205</td>
<td>205</td>
</tr>
<tr>
<td>PP+S-N</td>
<td>209</td>
<td>212</td>
<td>208</td>
<td>209</td>
<td>206</td>
<td>210</td>
</tr>
<tr>
<td>NDVI</td>
<td>0.699</td>
<td>0.674</td>
<td>0.691</td>
<td>0.693</td>
<td>0.703</td>
<td>0.682</td>
</tr>
</tbody>
</table>

Barker and Sawyer, 2011
Time of Nitrogen Application Summary

- Fall anhydrous ammonia less efficient than spring or split/sidedress
- Generally, little difference in corn yield or EONR between springtime N application timing; preplant, split/sidedress, or mid-vegetative
- If a springtime timing difference, not consistent between preplant and sidedress
- Even in extremely wet and N responsive conditions, similar corn yield and EONR
- Split applications are okay / application options
Why Little Spring Timing Difference?

- Not sandy (coarse textured) soils
- Soil organic matter mineralization
- Soil inorganic-N loss in wet springs makes sites more N responsive
- Applied N (fertilizer) loss if applied preplant, at-planting, or sidedress
  - Late spring or summer wet periods
- Less corn response to late applied N
- Corn N uptake timing has not changed
Why No Spring Timing Difference? 
Era Hybrid Comparison Study (2007-2008)

Era

<table>
<thead>
<tr>
<th>Era</th>
<th>1960</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>GY (bu/acre)</td>
<td>134b</td>
<td>224a</td>
</tr>
<tr>
<td>Total N uptake at R6 (lb/acre)</td>
<td>159b</td>
<td>190a</td>
</tr>
<tr>
<td>Grain N (lb/acre)</td>
<td>113b</td>
<td>138a</td>
</tr>
<tr>
<td>Grain (bu/lb N)</td>
<td>1.03b</td>
<td>1.42a</td>
</tr>
<tr>
<td>Grain N Concentration (%)</td>
<td>1.61a</td>
<td>1.23b</td>
</tr>
</tbody>
</table>